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Catching-up and club convergence from cross-national perspective. A statistical study for the period 1980-2010.

Preliminary version

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Abstract

The paper present the analysis outcomes on the catching-up process. Additionally it seeks for identifying the “convergence clubs” in cross-national section. It implements a traditional analysis of convergence tracking the catching-up process as well as the per capita income dynamics across time. The author finds no statistically significant relationship between average annual GDP PPP per capita growth rates (as exponential growth rate) and initial GDP PPP per capita (as natural logarithm) in a selected group of countries. The author also identifies the existence of “rich country cluster” and “poor country cluster” in the analyzed sample. The author applies for statistical analysis the country sample composed from 101 economies. All data concerning GDP PPP per capita are drawn from the IMF World Economic Outlook Database 2011. The time coverage is 1980-2010.

1. Introduction

Looking at the world map, a wide array of differences of different kinds is easily noticed. From strictly economic point of view, income inequalities seem to be crucial. No surprise that the changes of per capita income disparities are the in the very centre of the interest of

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economists, and as we know the income may differ between regions/countries for a number of reasons. However many empirical studies have been completed to find out about the directions, dynamics and reasons of such differences, no univocal answer has been obtained so far.

Different levels of GDP per capita are common in recent global economy. As different economies experience different GDP annual growth rate, the inequalities in average levels of GDP per capita across countries engrave. Such inequalities are even more visible as time passes by, and some poorer economies experience substantial difficulties in catching up with the high income countries. Analyzing the cross country GDP per capita levels, it can be seen that world economy is divided into two crucially different “worlds” – one constitutes countries with relatively high income, while the second one is composed out of the economies which are permanently lagging behind. The problem of catching up among countries is also connected with problems of catching up. It also implies the existence of the so called “club convergence”, which is recognized for group countries of similar features when GDP levels and GDP dynamics are taken into account.

The paper focuses on the question of income convergence among countries as well as discusses the phenomenon of the existence of club convergence. The author also wishes to verify the hypothesis about the possible catching up process that relatively poor countries are supposed to undergo.

2. Convergence clubs – theoretical considerations.

Present world economy is experiencing high income inequalities among countries. What is even more, there is much evidence on growing disparities among countries when their GDP per capita is taken into account. The income inequalities cannot be denied in any way, and that is rather obvious that different countries tend to undergo incomparable growth trajectories. It is not possible to assume that all countries follow the same growth process, and one must admit that the growth path is unique for each economy.

The existence of such extreme and unquestionable disparities is even more surprising when the hypothetical possibilities of stimulating economic growth are taken into consideration. Such inequalities are

not solely noticeable within countries but among them. Country's performance considering economic growth is uneven. Such crucial difference in annual GDP per capita growth enhance growing gap between the rich and poor countries. Yet, there is much debate on whether countries tend to converge or rather diverge over time. Despite a multiple cross-national empirical studies there is no clear evidence on permanent cohesive tendencies among countries. Many studies proof the existence of income convergence countries, as well as the lack of it. What shall be stressed here, in the growth economics literature, some define convergence as the process of approaching economies to the arbitrary defined state growth path, but also there is a stream that defines convergence as a catching-up process. That catching-up mainly refers to the poor countries, which shall catch up with the rich ones.

In recent literature overview there is a large strand of the detailed studies of the income convergence phenomena among countries. So far, the results are mixed and they do not give the strict answer to the question on the convergence. There is an essential need to shed a brighter light on the issues associated with the income convergence in cross-national samples, as well as to learn more about the question of forming convergence clubs. Many deep empirical analyses have been run, but so far, there is no unique theory that would explain the reason of why countries converge or diverge within some specific groups. What is even more there is many difficulties with defining the "groups". The term of "group of rich countries" or "group of poor countries" still is very general and does not tell much. The issues on convergence clubs and – what is strictly associated – existence of the so called *club convergence*, concentrate mainly on the analysis of the incidence of reduction in income gaps (divides) among countries assuming that each one is at a different stage of the overall development. In economic theory we can conclude on the existence of a convergence clubs if within a country group one can positively verify the hypothesis on a negative relationship between initial GDP per capita and average annual growth rate. If such relationship is statistically proofed it is justified to state that these countries create a convergence club. To clarify the concept of the convergence clubs, as to identify the groups of countries where the growth processes are assumed similar requires the arbitrary setting an income threshold. According to the set income

threshold countries should be sorted into groups in order to identify the different growth paths they follow.

In recent studies we can find on the convergence among world's best performing countries. However, even though we suppose intuitively that the convergence takes place, the likelihood of confirmations of finding the convergence among countries grouped by hazard is lower than finding about the divergence processes within the group. In addition, it is widely thought that the convergence processes are much more visible in relatively poor countries than in the rich ones. As proofed in some studies the "*nature of convergence at the top and bottom ends of the income spectrum also differs: catch up at the top and downward convergence at the bottom*"[†].

In Rostow[‡] works he concludes that world economies do converge over time. The changes observed are as if the poor countries catch up with high income ones. Other conclusions on income convergence we can find in the works of Baumol[§] - he identifies three different convergence clubs: (1) high income and industrialized countries which strongly converge; (2) middle income countries where the convergence is not proofed strongly; and (3) low income and poor countries where the rather the divergence is observed. Concluding – countries due to their different initial conditions they follow different growth paths. Also in works of Romer^{**} and Lucas^{††}, we find much on the issues, where there is some evidence on the convergence on the global sample. However some convergence tendencies are observed while countries are grouped, in the cross national study no such evidence is proofed. It means that in the global sample the hypothesis about the existing of negative relationship between the GDP per capital initial level and annual rate of GDP growth cannot be confirmed.

In the literature (see Quah, Lipsey, Zejan) there is also clear distinction between the two types of convergence clubs. One of the "clubs" can be defined as *upward convergence*, while the second one as the *downward*

[†] Ben David D., Convergence clubs and diverging economies, NBER and CEPR, Oct 1997

[‡] Rostow W.W., Why the poor get richer and the rich slow down?, Austin University of Texas Press 1980

[§] Baumol, W.J. (1986), Productivity growth, convergence and welfare: what the long run data show, *American Economic Review*, 76

^{**} Romer, P.M. (1986) Increasing returns and long run growth, *Journal of Political Economy*, 94,

^{††} Lucas, R.E. (1988) On the mechanics of economic development, *Journal of Monetary Economics*, 22,

convergence. The *upward convergence* takes place in case of poor countries catch up with the high income economies. The *downward convergence* is observed in case of wealthier countries where the growth of GDP per capita among the countries is hardly visible, and sometimes the growth rates are even negative. Obviously, the distinction between the two does not have to mean that within groups there are observed some convergence or divergence tendencies. The relationship between the “clubs” does not have to be of the same kind like the relationships among countries within clubs.

Along with the convergence clubs theory, there emerged the term of “club convergence”. The term “club convergence” refers to the situation when some countries tend to stay in the same country group over time, even though their income per capita grows at high pace. The countries that were classified as relatively poor 30 – 40 years ago, now – in 2010 – are still classified as relatively poor. That implies the existence of the “clusters of rich countries” and “clusters of poor countries”. The top and bottom clusters refer to the respective clubs. The membership of a specific club is mainly determined by the reference to a income threshold. The income threshold is usually an initial GDP per capita, according to which countries are classified and grouped.

The permanent existence of club convergence does not mean that the GDP per capita did not change in the mentioned period, but definitely can be interpreted as the lack of substantial changes in relationship between countries. It also means that countries tend to follow the same growth patterns in bundles, and not in isolation.

The phenomenon of club convergence also proof that the countries do not “jump” from one group to another or it happens very rarely. So even the economies can converge or diverge within some – usually arbitrary – defined groups, the members of the groups do not tend to exchange.

3. Statistical analysis

The main targets of the statistical analysis is to test for catching-up process among countries in the global perspective, as well as to check for the existence of the so called “club convergence” also in the global sample. If we assume that the catching-up process does take place, the hypothesis about the existence of statistical negative relationship between the average annual rate of growth and initial GDP per capita

(in here taken as natural logarithm) shall be confirmed. Also if we regress the two variables the coefficients shall be negative and statistically significant. If the hypothesis is confirmed it would proof that the catching up process does take place on the global scale. That would allow to conclude that countries with initially relatively low GDP per capita experience higher annual GDP per capita growth rates than high income countries. Such relations would let the poor countries to catch up with the rich ones. In the case of club convergence, the author verifies whether – over time – some countries changed the convergence club or not. On the scatter plot the author puts both on vertical and horizontal scale, the GDP per capita (expressed as natural logarithms) in the two following years – 1980 and 2010. So in the case the time difference is 30 years, with the star year -1980.

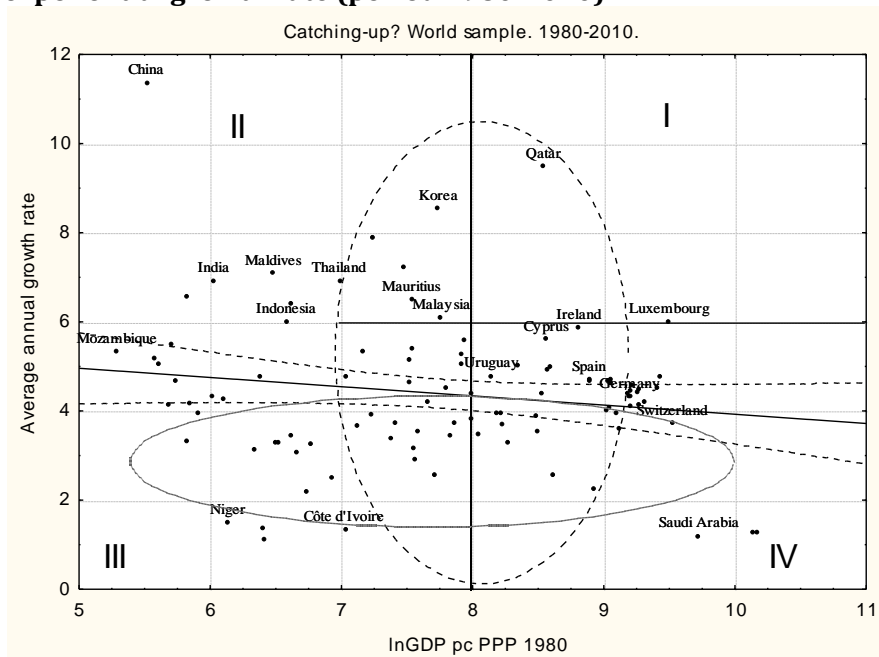
For the analysis purposes the author applies 101 countries. The time coverage is 1980-2010. All data are drawn from: International Monetary Fund Database.

a) Any catching-up? A global sample statistical analysis.

Firstly, the author analyses the case of 101 different countries trying to identify whether the convergence process on the global scale can be confirmed. As it can be easily concluded from the theoretical part of the paper, in the literature some crucially different conclusions can be derived about the convergence processes in the world countries.

The time coverage for the analysis is 1980-2010, and the country sample covers 101 economies. The scatter plot presented in chart 1 (see below), shows the statistical relationship between the GDP PPP per capita in 1980 (as natural logarithm) and the average annual exponential GDP per capita growth rate in the period 1980-2010.

Chart 1. GDP PPP per capita (year 1980) vs. average annual exponential growth rate (period 1980-2010).



Source: own elaboration using *STATISTICA 9* software.

As it can be concluded from chart 1, the statistical relationship between the two variables is hardly visible. In the case the correlation coefficient equals $r = (-0,15)$ and the $r^2 = 0,023$. The p-value is (0,123) which indicate no statistical significance. Based on such results it is not justified to state that, in the global sample, the catching up process can be observed. What is clearly visible in the chart 1, the average growth rates differ significantly across countries, even in the case of countries with similar initial GDP PPP per capita level (in the year 1980). Also it can be observed high density and differentiation among countries with initial GDP PPP per capita (as natural logarithm) that varies between from 7 to 9. Among these countries we can see that some managed to achieve astonishingly high growth rates, like Qatar (9,5% annually), Korea^{##} (8,5% annually), while – on the other side there are countries which failed totally in terms of GDP per capita growth. Among the “bad

^{##} Republic of South Korea

performers" are countries like: Côte d'Ivoire (1,3% annually) – the worst result, Gabon (2,3%) or Venezuela (2,5%). The group is very numerous; it counts 48 for countries, which constitute almost the half of the sample. In the case, if we observe such great disparities among countries in terms of their average annual GDP growth rate, the catching-up process is highly improbable. If the countries with relatively low initial GDP PPP per capita enjoyed the highest and stable growth rates in the 30-year period the convergence among world countries probably could be noticed.

On the other side, if we look once more at the chart 1, it can be easily seen that the counties with the annual growth rate varied from 2% to 4%, had significantly different initial GDP PPP per capita levels. Additionally the group of countries is also highly differentiated. Within the group we can find countries like Zambia (2,2% growth rate and GDP PPP per capita in 1980 – 845), but also Switzerland or Italy.

An outstanding example of an country of the best performance is Republic of China, with the very low initial GDP per capita in 1980 – 250 US PPP Dollars, and the average GDP per capita growth rate at 11,2% per year. That is the best result in the whole sample. In fact each country where the natural logarithm of its GDP PPP per capita in 1980 varied from 0 to 8, and at the same time the country managed to achieve higher than the average (the average is supposed to be the 6% annually) in the sample annual growth rates, are the best performers in the group. In the case of these economies, it would be justified to state that they are the countries where the possibility of catching-up with the high-income countries is possible to achieve. Among the countries are: China, South Korea, India, Maldives, Indonesia, Thailand, Mauritius, Malaysia, Lao People's Republic, Sri Lanka, Libya and Botswana.

If we divide the scheme into 4 quarters, the following conclusions can be derived:

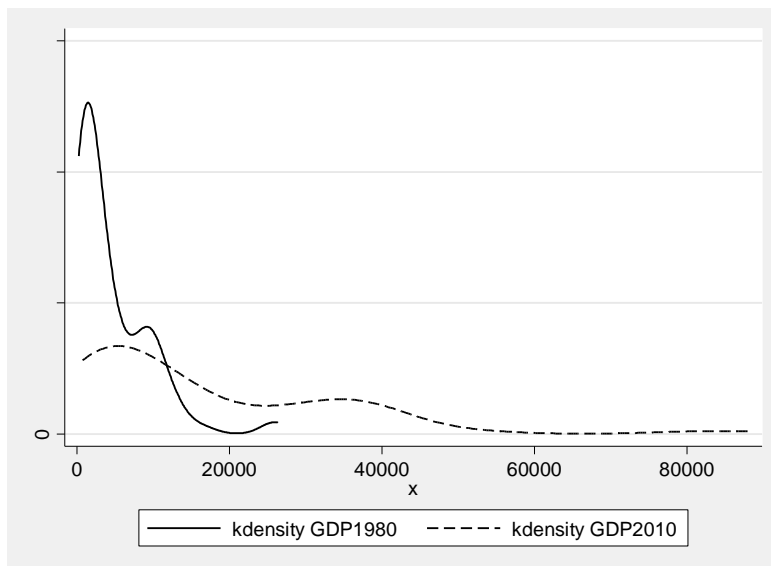
1. Countries in the I quarter are the best performing countries (in the global perspective), with the highest initial GDP per capita level, and at the same time achieving highest per capita growth rates. Countries in the group are the best performing economies in the world in terms of GDP per capita growth rates. These are the leading economies in that kind of classification. Only two countries belong to the group: Qatar and Luxembourg;

2. Countries in the quarter II, are the ones which could be treated as ones where the catching-up process can be identified. They are characterized by relatively low initial income and they achieve relatively highest per capita income annual growth rates. If they maintain the growth rates in the following years, they have a great opportunity to catch-up with the high income countries;
3. Countries in the quarter III are the permanently lagging behind economies, and are the worst performing countries in the whole sample. If they will not enjoy the stable and high-income growth rates in the following years they will never catch-up with the high income economies. The group is the most numerous and mostly composed of the countries we usually name “developing countries”;
4. Countries in the quarter IV, are the economies, with relatively high initial GDP per capita, that in the period 1980-2010 achieved lower than the average per capita income growth rates. In the group we find most of the Western European countries;
5. If countries from the quarter II and IV in the following years manage to maintain the present growth rates, it is highly probable that the income convergence would be the case in here. The income gap among countries from the two groups shall tend to lower;
6. Exactly the reverse situation we note in the case of countries in quarter I and III. If the countries will maintain the present growth rates in the following years, the income gap among the economies in the groups shall tend to grow at high pace.

Based on such results there is no basis to confirm the general hypothesis that countries with low initial GDP per capita tend to catch up with high-income countries. If that would be the case, there would be some basis to confirm the hypothesis about the income convergence on the global scale. From the analysis above it can be also concluded that means that probably the initial GDP level does not determine the future annual GDP growth rates, which is one the basic assumption of the catching-up hypothesis.

As the additional analysis, the author tests for general income inequalities among the countries included in the sample, in 1980 and afterwards – in 2010. In the chart 2 (see below), there are presented – as the overlaid two-way graphs, the Kernel Gaussian density functions for the GDP PPP per capita in 1980 and in 2010.

Chart 2. Kernel (Gaussian) density functions. Sample - 101 countries. Years 1980 and 2010.



Source: own elaboration using *STATA 9.0* software.

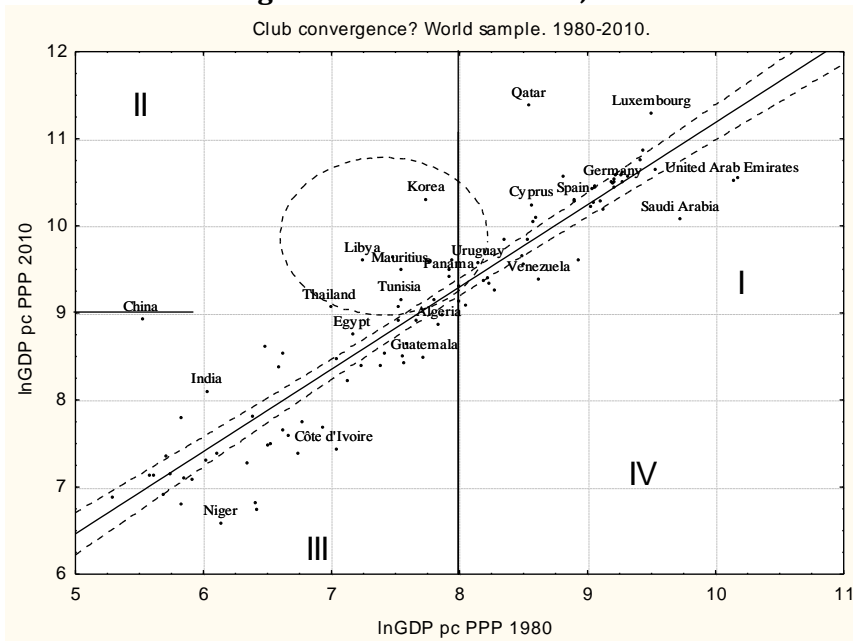
As it can be concluded from the chart 2, in 1980 the probability of being a relatively poor country was much higher than in the 2010. The concentration of countries with low GDP per capita was higher than in 2010. Although we can see that in 2010 the probability of being relatively poor country still exists, however it is much lower than it was in 1980. On such evidence it can be concluded that all countries experienced positive annual GDP per capita growth rates, but the distribution of growth was highly uneven among economies. It means that even low income countries (in 1980), which were supposed to achieve the relatively highest growth rates so that the catching-up process could be positively verified, did not so indeed. The growth rates (also seen in chart 1), in low income country group, varied substantially. The direct consequence of a very uneven growth distribution in the period 1989-2010, is greater polarization among countries in 2010, than it was in 1980. It does not mean that the GDP per capita in low-income countries (in 1980), decreased from then until now (in 2010). In fact, the GDP per capita did increase, however it does not mean automatically that the income gap between the “rich

ones and the poor ones” has diminished. Actually, the income gap increased in the period 1989-2010, which is mainly due to the insufficient growth rates in countries with low initial income per capita in 1980.

b) Club convergence? A global sample statistical analysis.

In the final part the analysis, the author test for club convergence in the previous applied country sample. To test for the club convergence, the author plots the natural logarithm of GDP PPP per capita in 1980 (horizontal axis) and the natural logarithm of GDP PPP per capita in 2010 (vertical axis).

Chart 3. Club convergence. Years 1989-2010, 101 countries.



Source: own elaboration using *STATISTICA 9* software.

The phenomenon of club convergence was clarified in the previous section. It was assumed that countries tend to stay in the same group over time, even if they experience substantial GDP per capita growth rates. If that is the case, the countries, which were classified as relatively poor in 1980, should be classified similarly in the year 2010.

To verify the hypothesis, the author analyzes the scatter plot above (chart 3). If the hypothesis about the existence of club convergence is to be confirmed, countries which were relatively poor in the year 1980, shall still be considered as relatively poor in 2010, forming a kind of “club”. Similarly, countries, which were classified as relatively rich in 1980, shall be classified in the same way in 2010, forming another “club”. Analyzing chart 3, it is justified to draw a conclusion that two such “clubs” can be identified. Both of them are formed from economies that lie in I and III quarter of the coordinates system. Economies, which can be found in the quarter I, are relatively rich countries, with high GDP PPP per capita, in 1980 and 2010. The opposite situation we find in the quarter III – countries in the “club” were relatively poor in 1980 and are still relatively poor in 2010. That is also proofs that on global scale the low-income economies do not actually catch-up with the high-income ones.

Countries in the quarter II are the economies that in the period 1980-2010 managed to catch-up significantly with the high-income economies. According to their GDP per capita in 1980, they were treated as poor countries, while – after 30 years, their GDP per capita can be easily compared with the per capita income of presently rich countries. It means that these economies managed “change” the convergence club and they tend to grow steadily as a reasonable pace, so that they can catch-up with the rich countries effectively.

4. Final remarks

The main aim of the author’s analysis was to test for the catching-up process among world countries, and to learn about the existence of club convergence among selected economies. The analysis outcomes are evident, that in the sample of 101 countries, no statistically significant relationship between initial GDP per capita and average annual growth rate was detected. On such basis, it is hardly possible to state that in the global perspective countries tend to converge in term of their per capita income. Nevertheless, on the other side, the convergence within rich countries’ group is much more prevalent than in the poor ones. Probably it is due to the fact, that poor countries group is more diversified and they face crucial structural difficulties disabling entering stable growth pattern.

The evidence on hardly any catching-up process is visible, and it was also confirmed by the clear formation of two numerous convergence clubs. It proves that countries, over time, tend to stay in the same country group, the same “club”. Only few economies managed to grow at a pace that enabled them to leave the “poor club”.

As a general conclusion, the author may claim that hardly any catching-up process can be detected in the period 1980-2010, and as a consequence the income gap between the rich and the poor ones is rather growing than diminishing.

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STATISTICAL APPENDIX

Table 1. GDP PPP per capita in 1980 and 2010. Exponential annual growth rate in the period 1980-2010. Country sample – 101 economies.

Country	GDP PPP per capita in 1980	GDP PPP per capita in 2010	Exponential annual growth rate (period 1980-2010)
Albania	1845	7380	4,6
Algeria	2535	7103	3,4
Argentina	4857	15603	3,9
Australia	10081	39692	4,6
Austria	10488	39454	4,4
Bahrain	9148	26807	3,6
Bangladesh	301	1565	5,5
Belgium	9759	36274	4,4
Benin	568	1453	3,1
Bolivia	1930	4584	2,9

Botswana	1772	15449	7,2
Brazil	3741	11289	3,7
Bulgaria	3697	12052	3,9
Cameroon	1027	2165	2,5
Canada	11109	39033	4,2
Chile	2824	14982	5,6
China	250	7517	11,3
Colombia	2446	9445	4,5
Côte d'Ivoire	1135	1686	1,3
Cyprus	5227	28044	5,6
Denmark	10028	36763	4,3
Dominican Republic	1849	8647	5,1
Ecuador	2597	7951	3,7
Egypt	1293	6367	5,3
El Salvador	2120	7442	4,2
Ethiopia	294	1014	4,1
Fiji	1381	4450	3,9
Finland	8598	34401	4,6
France	9958	34092	4,1
Gabon	7565	14865	2,3
Gambia	786	1972	3,1
Germany	9834	35930	4,3
Ghana	448	1609	4,3
Greece	8509	28833	4,1
Guatemala	2255	4871	2,6
Honduras	1608	4404	3,4
Hungary	5062	18815	4,4
Iceland	10642	36681	4,1
India	415	3290	6,9
Indonesia	726	4380	6,0
Iran	2973	11024	4,4
Ireland	6711	38816	5,9
Israel	7278	29404	4,7
Italy	8993	29417	4,0
Jamaica	3115	8811	3,5
Japan	8377	33828	4,7

Jordan	1964	5658	3,5
Kenya	665	1784	3,3
Korea	2301	29791	8,5
Kuwait	26325	38293	1,2
Lao People's Democratic Republic	341	2435	6,6
Lesotho	313	1266	4,7
Libya	1397	14878	7,9
Luxembourg	13329	80304	6,0
Madagascar	607	910	1,3
Malawi	338	908	3,3
Malaysia	2350	14603	6,1
Maldives	656	5483	7,1
Mali	348	1206	4,1
Malta	5431	24081	5,0
Mauritania	751	2099	3,4
Mauritius	1886	13214	6,5
Mexico	4926	14265	3,5
Morocco	1147	4773	4,8
Mozambique	199	982	5,3
Nepal	265	1249	5,2
Netherlands	10686	40777	4,5
New Zealand	8286	27421	4,0
Niger	461	720	1,5
Norway	12558	52238	4,8
Panama	2744	12397	5,0
Papua New Guinea	869	2302	3,2
Paraguay	1916	4915	3,1
Peru	2963	9281	3,8
Philippines	1247	3725	3,6
Poland	4205	18836	5,0
Portugal	5269	23113	4,9
Qatar	5142	88232	9,5
Romania	3615	11766	3,9
Rwanda	369	1202	3,9

Saudi Arabia	16654	23742	1,2
Senegal	680	1814	3,3
South Africa	3927	10505	3,3
Spain	7280	29651	4,7
Sri Lanka	750	5103	6,4
Sudan	592	2465	4,8
Sweden	9984	37775	4,4
Switzerland	13748	41765	3,7
Syrian Arab Republic	1669	5107	3,7
Tanzania	412	1497	4,3
Thailand	1089	8643	6,9
Togo	610	847	1,1
Tunisia	1888	9488	5,4
Turkey	2756	13392	5,3
Uganda	274	1245	5,0
United Arab Emirates	25402	36973	1,3
United Kingdom	8601	35052	4,7
United States	12249	47131	4,5
Uruguay	3430	14341	4,8
Venezuela	5515	11889	2,6
Zambia	845	1625	2,2

Source: own compilation and calculations based on data derived from IMF World Economic Outlook Database, IMF 2011.